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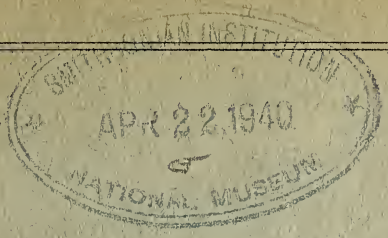


PART 1.

# TRANSACTIONS

OF THE

# SOCIETY FOR BRITISH ENTOMOLOGY

EDITED BY

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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 7. 31ST MARCH, 1940. PART 1.

# DYTISCIDAE AND HALIPLIDAE (COL.) IN THE LAKE DISTRICT.

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## 1. DEFINITION OF THE LAKE DISTRICT.

In his account of its geology, Marr (1916) defines the Lake District as the country lying within a ring of carboniferous limestone which surrounds it on all sides except the south-west, where there are beds of Permian and Trias. There is also a small gap to the east over Shap Pass, where the Lake District rocks are continuous with those of the Pennines, and here it is necessary to make an arbitrary boundary; I have used the main road from Kendal to Shap. The Lake District thus defined is shown in Fig. 1, which is based on the map in Marr's 'Geology of the Lake District.'

Except to the south, where there are some complicated outcroppings, this geological boundary is smooth and well-marked. It seems the most satisfactory boundary for the ecologist, for all the rocks within it are hard and poor in lime, and the habitats on them can differ one from another in only a limited number of

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features. The three main geological formations are the Skiddaw slates to the north, the Borrowdale volcanic series in the middle and the Bannisdale slates to the south. The Lake District lies in three counties: Westmorland (WL), Cumberland (CU), and the Furness division of N. Lancashire; but according to Balfour-Browne's (1931) typomap scheme, which I have used for all ecological work in the Lake District, the Furness division of Lancashire is treated as part of Westmorland.

## 2. Source of Records.

In the centre and south of the district, collections have been made by the author (see Macan, 1938, for map of localities); in the north collections have been made by Mr. F. H. Day, who has been investigating the beetle fauna of Cumberland for some forty years, though, unfortunately for the present work, most of his hill-collecting has been done on the Pennines. Other collectors who have published records have only been able to work the district during short vacations.

The records are taken from three sources:—

1. My own collecting, extending over a period of three years. It may be remarked that during the first two years beetles were only collected incidentally during the course of other work. I have incorporated in Class 1 collections made by Miss J. Wans, a member of the 1937 Easter Class, and by Mr. H. P. Moon during the course of his work on the littoral fauna of Windermere (Moon, 1934, 1936). I wish to offer my best thanks to Professor F. Balfour-Browne, who identified the Dytiscidae and part of the Haliplidae, and to the Rev. E. J. Pearce, who identified the rest of the Haliplidae.

2. Unpublished records kindly communicated by Professor F. Balfour-Browne, Mr. F. H. Day and the Rev. E. J. Pearce.

3. Published records. I am indebted to Professor Balfour-Browne for a list of references.

In the lists below the source of the records is indicated by the appropriate numeral.

## 3. Description of Habitats.

In a previous paper (Macan, 1938) the aquatic habitats in the Lake District have been divided into three main types: pools, tarns and lakes. The basis of the classification is Pearsall's (1920) work on vegetation and aquatic soils. The accumulation of soil which is continually going on in almost any aquatic environment is accompanied by changes in the vegetation, and there is a succession of plant species. It is found that the species making up the succession are different in different places, and this difference

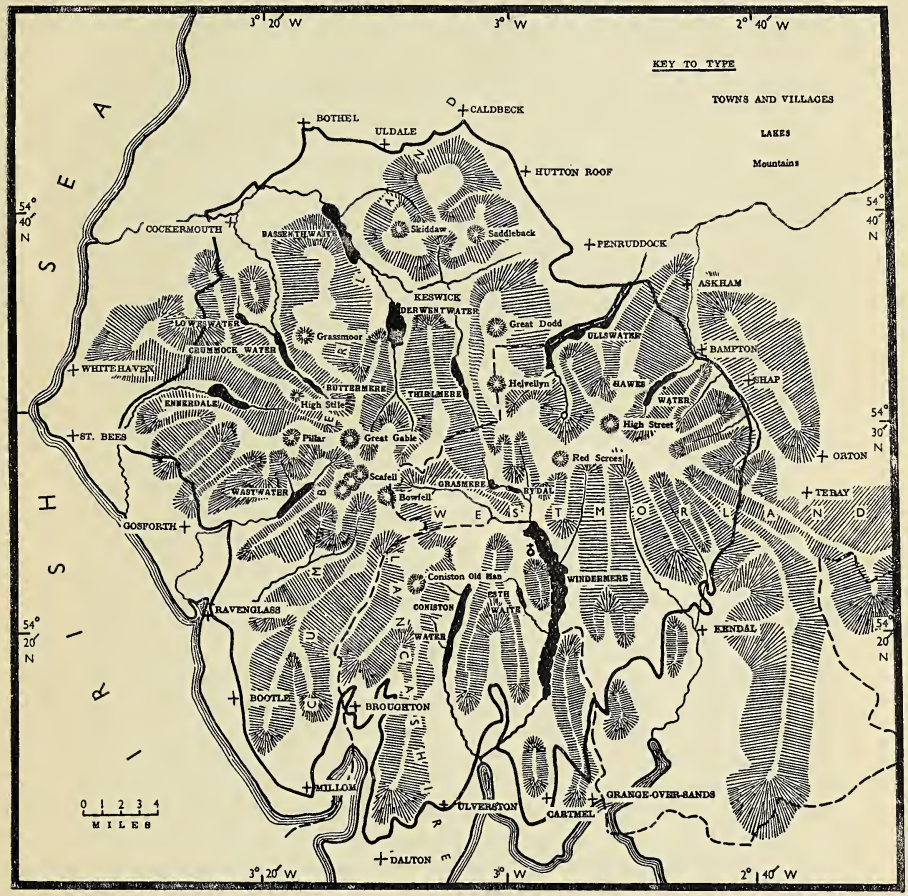


FIG. 1.—The Lake District as defined for faunistic studies. The boundary is marked by a heavy line, county boundaries by broken lines and the position of Wray Castle is indicated by ☥

appears to be related to the rate at which the percentage of organic matter in the soil is increasing. Soil is made up of vegetable remains, which contribute organic matter, and inorganic silt particles. These silt particles contain bases, and in the presence of bases the vegetable remains decompose and the percentage of organic matter in the soil increases at a slow rate; on the other hand, where bases are poor there is little decomposition of plant remains and the percentage of organic matter in the soil increases rapidly. Pools, tarns and lakes are three terms in a series in

which the rate of increase of the percentage organic matter in the soil is progressively less rapid: pools have little or no silt, and the rate of increase of the percentage organic matter in the soil is rapid; lakes are fed by large streams and rivers, bringing an abundant supply of silt, and the rate of increase is low; while tarns occupy a position between the two. Pearsall (1920) has shown that the amount of organic matter in a soil and the rate at which it is increasing are factors of fundamental importance in the ecology of aquatic plants, and Macan (1938) has put forward evidence to suggest that the same factors influence the distribution of Corixidae, and it seems, therefore, that as far as the Lake District is concerned, they are a reliable foundation on which to base a classification of bodies of freshwater.

Pools are small shallow collections of water lying in rock crevices, or more usually in eroded basins in beds of peat; there is usually no flow and, as already noted, the amount of organic matter in the soil is high. The term pool suggests a transient body of water, but most of the Lakeland pools, though often of small size, seldom dry up, the reason being that the beds of peat in which most of them lie are very retentive of moisture.

Pools may be divided into *high pools, low pools* and *quarry pools*. The first two are usually shallow (about 0·5 m.) with a relatively large surface area, while quarry pools are deep (1-2 m.) with a relatively small surface area. Cover is provided by bare slates, dead leaves or vegetation. High pools and low pools have been divided on their Corixid fauna; the altitude separating the two is about 450 m. (1,500 ft.). High pools harbour *Sigara wollastoni* and *S. nigrolineata*; their pH lies usually between 4.0 and 5.0 and they seldom contain any vegetation other than *Sphagnum* and *Hypnum fluitans* (s.l.), both of which mosses may form dense beds. Low pools harbour *Sigara scotti* and *S. castanea*; their pH lies usually between 4.5 and 6.5, and besides mosses they may contain such plants as *Menyanthes trifoliata* Linn., *Juncus fluitans* Lam., *Utricularia* sp. and *Carices*.

Tarns are larger and deeper than pools and the water is held up by a dam. There are feeding streams, but these are small, and the quantity of silt brought in is slight, so that tarns also have a soil in which the percentage of organic matter is high. They may be divided into *high tarns* and *low tarns,* though actually the altitude factor is incidental, the important difference being the method of formation. High tarns are of glacial origin; they usually lie in regions exposed to severe winds, and the consequent disturbance of the water keeps the shores free of any fine soil and they remain rocky or stony. Low tarns are recent creations of man, and as they now lie over land on which peat had previously been formed they have soil-covered bottoms on which are found such plants as *Littorella lacustris* Linn., *Lobelia Dort-*

*manni* Linn., *Myriophyllum* sp., *Callitriche* sp., *Potamogeton natans* Linn., *Castalia alba* Wood, *C. minor* D.C., *Juncus fluitans* Lam., *Apium inundatum* Reichb., *Utricularia* sp., *Menyanthes trifoliata* Linn. and *Carex* spp. Except for the *Carex* beds the vegetation is seldom dense. The pH is commonly a little on the acid side of neutral.

Lakes have a yet greater surface area and depth: they lie in eroded valleys and the water is usually held up by a morainic dam as well. They occupy the main valleys, are fed by streams of considerable size and, therefore, receive an abundant supply of silt, so that the amount of organic matter in the soil is low. Around much of the shore-line, wave-action prevents the settling of fine particles of soil, and there are only bare rock faces or large stones. In more sheltered places swards of *Littorella* are found, and well-sheltered bays have an emergent flora of such plants as *Typha latifolia* Linn., *Phragmites communis* Trin., *Scirpus lacustris* Linn., *Equisetum limosum* Linn. and *Carex inflata* Huds. In the deeper water there is a thick growth of such plants as *Elodea canadensis* Michx., *Nitella opaca* Ag., *Myriophyllum* spp. and *Potamogeton* spp.

As already noted, pools, tarns and lakes fall into a continuous series, and distinctions between them are of necessity arbitrary. It is convenient to distinguish pools by the absence of any sort of dam, and a criterion which has been found to work well in practice for separating tarns and lakes is the nature of the emergent vegetation. The term tarn is used for bodies of water where the dominant emergent is *Carex* (sedge), and the term lake is used for bodies of water where the dominant emergent is *Phragmites* (reed). According to this definition, certain large low-lying bodies of water, commonly called tarns (*e.g.* Blelham Tarn, Loughrigg Tarn, Little Langdale Tarn, etc.), are lakes. The local name for such bodies of water has been retained in the records, but the word ' tarn ' is put in inverted commas.

### 4. Records of Coleoptera.

The names used are those recommended by Balfour-Browne (1938). In most of the lakes, and particularly in Windermere, a number of stations have been worked. Where one species of beetle has been found at two or more stations in one lake the number of stations is shown in brackets. In Tables 1 and 2 the number of records in the column headed ' lakes ' indicates the number of stations at which the species in question was found. Further, when one lake occurs in two classes, it is counted as two records. On the other hand, though more than one station has been worked in many pools and tarns, these are not treated separately in the records and tables; each tarn or pool is treated as a unit.

HALIPLIDAE.

*Brychius elevatus* Panz.

1. One specimen from weed-beds in R. Gilpin, WL.

*Haliplus confinis* Steph.

1. Three specimens from 3 reed-beds in 2 lakes: Windermere (2), WL: Knittleton 'Tarn,' WL; 16 specimens from 5 low tarns, all WL.

*H. lineatocollis* Marsh.

1. One specimen from a lake reed-bed: Helton 'Tarn,' WL; 1 specimen from a running-water locality: R. Gilpin, WL; 4 specimens from a low tarn, WL; 1 specimen from a low pool, WL; 3 specimens from 2 quarry pools, both WL.
2. Four lakes: Windermere, WL, coll. K. G. Blair, E.J.P.: Bassenthwaite, CU, vii.32, F.B.-B.: Ullswater, CU/WL, common: Brotherswater, WL, common, 25.v.35, F.H.D.; 1 high tarn: Angle Tarn, Patterdale, WL, 12.ix.21, E.J.P.

*H. ruficollis* Deg.

1. Ten specimens from 6 reed-beds in 4 lakes: Windermere, WL: Coniston (2), WL: Helton 'Tarn' (2), WL: Bassenthwaite, CU; 47 specimens from weed- or reed-beds in 9 low tarns, all WL; 1 specimen from a quarry-pool, WL; 2 specimens from a low pool, WL.
2. One lake: Ennerdale, CU, vii.32, F.B.-B.; low pools, Bowscale Moss, CU, F.H.D.

*H. heydeni* Wehn.

1. Two specimens from 2 quarry pools, both WL; 1 specimen from a low pool, WL.
2. Two lakes: Ullswater, CU/WL, sparingly: Brotherswater, WL, common, 25.v.35, F.H.D.
3. One high tarn: Angle Tarn, Patterdale, WL, Pearce, 1937.

*H. fluviatilis* Aubé.

1. Three specimens from weed-beds in: 1 lake: Helton 'Tarn'; 1 low tarn; R. Gilpin, all WL.

*H. lineolatus* Mann. form *nomax* B.-B.

1. Twenty-one specimens from 9 reed-beds in 4 lakes: Windermere (6), WL: Loughrigg 'Tarn,' WL: Blelham 'Tarn,' WL: Bassenthwaite, CU; 2 specimens from 1 low tarn, WL.

2. Two lakes: Rydal, WL: Loweswater, CU, vii.32, F.B.-B.; 1 unspecified locality: Kendal, coll. K. G. Blair, E.J.P.

*H. immaculatus* Gerh.

1. One specimen from a reed-bed in a lake: Windermere, WL.

*H. wehnckei* Gerh.

1. Twenty-eight specimens from 10 weed- or reed-beds in 7 lakes: Windermere (2), WL: Ullswater, WL: Grasmere, WL: Helton 'Tarn,' WL: Derwentwater, CU: Bassenthwaite (2), CU: Coniston (2), WL; 6 specimens from 3 low tarns, all WL.

2. Two lakes: Windermere, WL, coll. K. G. Blair, vi.29, E.J.P.: head of Ullswater, WL, coll. A. Hastings, vii.32, F.B.-B.; running water: several in small stream, Bowscale, CU, 29.viii.36, F.H.D.

*H. fulvus* Fab.

1. Forty-one specimens from 18 stations in 8 lakes: Windermere (9), WL: Esthwaite, WL: Knittleton 'Tarn,' WL: Helton 'Tarn,' WL: Brotherswater, WL: Coniston (2), WL: Derwentwater (2), CU: Bassenthwaite, CU; 53 specimens from 17 low tarns, all WL; 1 specimen from a high tarn: Low Water, WL; 2 specimens from 2 quarry pools, both WL.

2. Six lakes: Loweswater, CU: Ennerdale, CU: Buttermere, CU: Derwentwater, CU: Windermere, WL, vii.32, F.B.-B.: Ullswater, CU/WL, common, 25.v.35, F.H.D.; 1 low tarn: Tarn Hows, WL, 1933, coll. A. Hastings, F.B.-B.; 1 high tarn: Angle Tarn, Patterdale, WL, 12.ix.21, E.J.P.

*Remarks.* Four out of the nine stations in Windermere were exposed stony shores, and similar conditions obtained in Three Dubs Tarn and Low Water. This species and *H. flavicollis* were the only two which occurred at all in places where there was not considerable shelter.

*H. flavicollis* Sturm.

1. Nineteen specimens from 9 stations in 5 lakes: Windermere (5), WL: Brotherswater, WL: Ullswater, WL: Helton 'Tarn,' WL: Derwentwater, CU; 8 specimens from 2 low tarns, both WL.

2. Two lakes: Windermere, WL: Loweswater, CU, vii.32, F.B.-B.; 1 unspecified locality: Kendal, WL, coll. K. G. Blair, vi.29, E.J.P.

*Remarks.* Two of the four stations in Windermere were exposed stony shores.

DYTISCIDAE.

*Laccophilus minutus* Linn. (= *variolosus* Herbst.) (= *obscurus* Panz.).

1. Many specimens from 3 low tarns, all WL.

*Hyphydrus ovatus* Linn.

1. Five specimens from 4 reed-beds in 3 lakes: Windermere, WL: Blelham 'Tarn' (2), WL: Loughrigg 'Tarn,' WL; 28 specimens from 7 low tarns, all WL; 1 specimen from a high pool, CU; 1 specimen from a quarry pool, WL.

*Hygrotus inaequalis* Fab.

1. Six specimens from 3 reed-beds in 3 lakes: Helton 'Tarn,' WL: Loughrigg 'Tarn,' WL: Knittleton 'Tarn,' WL; 30 specimens from 7 low tarns, all WL; 1 specimen from a quarry pool, WL.
2. One lake: Rydal Water, WL, coll. J. H. Barclay, F.B.-B.

*H. quinquelineatus* Zett.

1. Two specimens from a lake reed-bed: Bassenthwaite, CU.

*H. versicolor* Schall.

1. One specimen from a low tarn, WL.

*H.* (*Coelambus*) *novemlineatus* Steph.

1. One specimen from a lake reed-bed: Bassenthwaite, CU.
2. One lake: Bassenthwaite, CU, vii.32, F.B.-B.

*H.* (*C.*) *impressopunctatus* Schall.

3. One lake: Ullswater, CU/WL, Dr. Leach, Day, 1912.

*Deronectes duodecimpustulatus* Fab.

1. One specimen from a lake: Knittleton 'Tarn,' WL; 3 specimens from 2 low tarns, both WL; 1 specimen from a quarry pool, WL.
2. Two lakes: Bassenthwaite, CU: Loweswater, CU, vii.32, F.B.-B.; running water: Bowscale Moss, CU, 5.x.25, F.H.D.
3. Running water: 'rapid river Rothay,' WL, Blackburn, 1864: abundantly near Ambleside in ponds formed by the Rothay, WL, Blackburn, 1865.

*D. assimilis* Payk.

1. Many specimens in 9 reed-beds in 6 lakes: Windermere, WL: Esthwaite, WL: Grasmere, WL: Blelham 'Tarn' (2), WL: Loughrigg 'Tarn' (2), WL: Bassenthwaite (2), CU; many specimens in weed-beds in 6 low tarns, all WL; several specimens in 2 quarry pools, both WL; 1 specimen in a stream, WL; 1 specimen in a rot-hole in a birch tree, WL.
2. One lake: Rydal, WL, vii.32, F.B.-B.
3. One unspecified record: Keswick, CU, 36 specimens, Rye, 1876.

*D. depressus* Fab.

1. Many specimens at 19 stations in 7 lakes: Windermere (12), WL: Rydal, WL: Grasmere, WL: Ullswater, WL: Helton 'Tarn,' WL: Derwentwater, CU: Bassenthwaite (2), CU; many specimens in weed-beds in 2 running water localities: Blelham Beck, WL: R. Gilpin, WL; many specimens in 5 low tarns, all WL; several specimens in a quarry pool, WL.
2. Nine lakes: Bassenthwaite, CU: Loweswater, CU: Ennerdale, CU: Buttermere, CU: Derwentwater, CU: Rydal, WL, vii.32, F.B.-B.: Ullswater, WL: Windermere, WL: Coniston, WL, 1932, coll. A. Hastings, F.B.-B.

*Remarks.* Three of the Windermere stations and the single Rydal station were exposed, with *Littorella,* and many of the reed-bed stations were exposed too. One specimen was obtained in Windermere by dredging through beds of *Elodea* and *Myriophyllum* in a depth of 2 m.

*D. elegans* Panz.

2. One lake: Brotherswater, WL, several, 25.v.35, F.H.D.; running water: small stream, Bowscale, CU, 29.viii.36, F.H.D.
3. Running water: 'rapid river Rothay,' WL, Blackburn, 1864.

*Oreodytes borealis* Gyll. (=*davisii* Curt.).

1. One specimen from a high pool, CU.
2. Running water: clear stream, Brandy Gill, CU, 4.v.35, F.H.D.
3. 'In Langdale in running water,' Blackburn, 1865.

*O. septentrionalis* Gyll.

2. Two lakes: Ennerdale, CU, vii.32, F.B.-B.: Bassenthwaite, CU, vii.32, F.B.-B., 15.vi.35, common, F.H.D.; 1 high tarn: Angle Tarn, Patterdale, WL, 12.ix.21, E.J.P.

3. One unspecified locality: Buttermere district, CU, Allen, 1913.

*O. rivalis* Gyll.

1. One specimen from a stream, WL.
2. Edges of stream, Brandy Gill, CU, 4.v.35, F.H.D.

*Hydroporus* (*Graptodytes*) *pictus* Fab.

1. Thirteen specimens from 6 reed-beds in 4 lakes: Windermere (2), WL: Coniston (2), WL: Derwentwater, CU: Bassenthwaite, CU; many specimens from 5 low tarns, all WL; 4 specimens from a quarry pool, WL.

*H.* (*G.*) *granularis* Linn.

1. One specimen from a low pool, WL.

*H.* (*G.*) *lepidus* Ol.

1. Two specimens from a quarry pool, WL.
2. Two running water localities: R. Duddon near Ulpha, CU, several, 19.iv.36, F.H.D.: Bowscale Moss, CU, 3.iv.26, F.H.D.

*H. tristis* Payk.

1. Many specimens from a *Sphagnum*-bed in a low tarn, WL; 9 specimens from 3 low pools, all WL; 1 specimen from a quarry pool, WL.
2. One low pool: pool beside Ennerdale, CU, vii.32, F.B.-B.; 1 high pool: Saddleback, CU, 2.vii.12, F.H.D.
3. One unspecified locality: 'two small puddles, each about a yard across at the widest part,' Lake District, Blackburn, 1864; high pools: peat pools at about 2,000 feet, Rydal Fell, WL, Black, 1904.

*H. umbrosus* Gyll.

1. Three specimens from reed-beds in 2 low tarns, both WL.
2. Low pools: Mungrisedale Moss, CU, common, 2.v.25, F.H.D.

*H. angustatus* Sturm.

2. One low pool: boggy pond, Bowscale, CU, 29.viii.36, F.H.D.

*H. gyllenhalii* Schiöd.

1. One specimen from a lake reed-bed: Knittleton 'Tarn,' WL; many specimens from 2 low tarns, both WL; 17 specimens from 5 low pools, all WL.
2. Two low pools: pool beside Ennerdale, CU, vii.32, F.B.-B.: boggy pond, Bowscale, CU, 29.viii.36, F.H.D.

3. Two high pools: peat pools about 2,000 feet, Rydal Fell, WL, Black, 1904: Saddleback, CU, Day, 1912.

*H. morio* Aubé (Dej.).

1. Twenty-one specimens from 9 localities, all high pools, 6 CU, 3 WL.
2. One high pool: Skiddaw, CU, coll. A. J. Chitty, Oxford Univ. Mus. Coll., F.B.-B.
3. One high tarn: Sprinkling Tarn, CU, Day, 1912; 4 high pools: shallow peaty pool near Angle Tarn, CU, Thornley, 1894: Esk House locality, CU, present in limited numbers, Day, 1900: peat pools, about 2,000 feet, Rydal Fell, WL, Black, 1904: Saddleback, CU, Day, 1912.

*H. striola* Gyll. = (*vittula* Er.).

1. One specimen from a lake: Windermere, WL.

*H. palustris* Linn.

1. Many specimens from 8 reed-beds in 6 lakes: Windermere (3), WL: Grasmere, WL: Coniston, WL: Blelham 'Tarn,' WL: Helton 'Tarn,' WL: Bassenthwaite, CU; 69 specimens from 13 low tarns, all WL; 22 specimens from 5 quarry pools, all WL; 3 specimens from 3 low pools, all WL; 21 specimens from 1 high pool, CU.
2. Six lakes: Rydal, WL, 1900, coll. J. H. Barclay, F.B.-B.: Rydal, WL: Bassenthwaite, CU: Loweswater, CU: Ennerdale, CU: Buttermere, CU: Derwentwater, CU, vii.32, F.B.-B.; 1 high tarn, Leverswater, WL, 1932, coll. A. Hastings, F.B.-B.; 1 high pool: Esk House, CU, 1932, coll. A. Hastings, F.B.-B.; low pools: Bowscale and Mungrisedale Mosses, CU, F.H.D.

*H. incognitus* Sharp.

1. One specimen from a low tarn, WL; several specimens from 3 quarry pools, all WL; 1 specimen from a high pool, CU.

*H. erythrocephalus* Linn.

1. Three specimens from 3 low tarns, all WL; 16 specimens from 7 low pools, all WL.
2. One lake: Windermere, WL, MS. notes of J. F. Dutton, F.B.-B.; 1 low tarn: Tarn Hows, WL, coll. A. Hastings, F.B.-B.; low pools: Bowscale and Mungrisedale Mosses, CU, F.H.D.

*H. rufifrons* Duft.

1. One specimen, locality unspecified; 3 specimens from 1 low tarn, WL; 1 specimen from 1 low pool, WL.

*H. longulus* Mul.

3. One unspecified locality: Buttermere district, CU, Allen, 1913.

*H. melanarius* Sturm.

2. Two lakes: Ennerdale, CU, vii.32, F.B.-B.: Derwentwater, CU, flood-rubbish on side of lake, 11.v.35, F.H.D.

3. One unspecified locality: 'two small puddles each about a yard across at the widest part,' Blackburn, 1864; 1 high pool: 'high up on Saddleback in a boggy pond,' CU, Day, 1912.

*H. memnonius* Nic.

1. Two specimens from 2 low pools, both WL.

3. One lake: Ullswater, CU/WL, twice captured by Dr. Leach, Day, 1912.

*H. obscurus* Sturm.

1. One specimen from a lake reed-bed: Knittleton 'Tarn,' WL; 2 specimens from a low tarn, WL; 3 specimens from 3 high pools, 2 CU, 1 WL; 7 specimens from 3 low pools, all WL.

2. Two low pools: boggy pond, Bowscale, CU, 29.viii.36, F.H.D.: Mungrisedale Moss, CU, 2.v.25, F.H.D.

3. Three high pools: Esk House locality, CU, Day, 1900: peat pools about 2,000 feet, Rydal Fell, WL, Black, 1904: near Scafell, CU, Day, 1912; 1 unspecified locality: 'two small puddles each about a yard across at the widest part,' Blackburn, 1864.

*H. nigrita* Fab.

1. Five specimens from 2 quarry pools, both WL; 3 specimens from a low pool, WL.

2. One low pool: boggy pond, Bowscale, CU, 29.viii.36; 1 high pool: Saddleback, CU, 28.vi.11, F.H.D.

3. One unspecified locality: 'two small puddles each about a yard across at the widest part,' Blackburn, 1864.

*H. pubescens* Gyll.

1. Twenty-four specimens from 10 high pools, 4 WL, 6 CU; 26 specimens from 5 low pools, all WL; 7 specimens from 4 quarry pools, all WL.

2. One lake: Ennerdale, CU, vii.32, F.B.-B.; 2 low pools: pool beside Ennerdale, CU, vi.32, F.B.-B.: Bowscale Moss, CU, F.H.D.; 1 high pool: Saddleback, CU, common, F.H.D.

3. One high pool: peat pools about 2,000 feet, Rydal Fell, WL, Black, 1904.

*H. planus* Fab.

1. Two specimens from a quarry pool, WL.

*Agabus guttatus* Payk.

1. One specimen from a high tarn: Low water, WL.
2. One high pool: Skiddaw, CU, Dublin Mus., F.B.-B.; 2 running water localities: Brandy Gill, CU, 'common in moss on boulders in stream,' 4.v.35, F.H.D.: Mungrisedale Moss, CU, 'one or two under stones in dry stream bed,' 30.vi.25, F.H.D.
3. Two high pools: Helvellyn, CU/WL, Blackburn, 1865: Sty Head, CU, Day, 1912.

*A. affinis* Payk.

1. Nine specimens from a reed-bed in a low tarn, WL; 4 specimens from 2 low pools, both WL.
2. One low pool: Mungrisedale Moss, CU, 2.v.25, F.H.D.

*A. unguicularis* Thoms.

3. One high pool: shallow peaty pool near Angle Tarn, CU, Thornley, 1894.

*A. congener* Payk.

1. Two specimens from 2 high pools, 1 CU, 1 WL.
2. One high pool: Skiddaw, CU, Power coll., Brit. Mus. (Nat. Hist.), F.B.-B.; 1 high tarn: Angle Tarn, CU, coll. A. Thornley, F.B.-B.
3. ? Three high tarns: Styhead and adjacent tarns, CU, Blackburn, 1865 (bright red vars.); 3 high pools: Esk Hause locality, CU, not uncommon in small pools, Day, 1900: Scafell, CU: Saddleback, CU, Day, 1912; 1 unspecified locality: Patterdale, WL, (Britten) Day, 1918.

*A. labiatus* Brahm = (*femoralis* Payk.).

1. One specimen, locality unspecified.

*A. arcticus* Payk.

1. Many specimens from 6 high pools, 3 CU, 3 WL.
2. One high pool: pool above Angle Tarn, CU, coll. A. Hastings, 1932, F.B.-B.
3. Three high pools: shallow peaty pool near Angle Tarn, CU, Thornley, 1894: Esk Hause locality, CU, not uncommon in small pools, Day, 1900: near Sprinkling Tarn under Scafell, CU, (Britten and Day) Day, 1912; 1 high tarn: Buttermere district, CU, abundant in a tarn at 1,700 feet, Allen, 1913.

*A. sturmii* Gyll.

1. One specimen from a lake reed-bed: Coniston, WL; 21 specimens from 6 low tarns, 5 WL, 1 CU; 1 specimen from a low pool, WL; 11 specimens from 3 quarry pools, all WL; 2 specimens from a high pool, WL.
2. One low pool: Bowscale Moss, CU, 3.iv.26, F.H.D.
3. One unspecified locality: Patterdale, WL, (Britten) Day, 1918.

*A. chalconatus* Panz.

1. Five specimens from 3 low pools, all WL; 1 specimen from a high pool, WL.

*A. bipustulatus* Linn.

1. Two specimens from 2 low tarns, both WL; 8 specimens from 6 low pools, all WL; 7 specimens from 4 quarry pools, all WL; several specimens from 3 high tarns, 2 WL, 1 CU; many specimens from 14 high pools, 7 WL, 7 CU.
2. One high pool: peat pool near Blea Tarn, Wythburn, CU, coll. A. Hastings, 1933, F.B.-B.; 2 high tarns: Sprinkling Tarn, CU, 9.vi.00: Scales Tarn, CU, 30.vi.25, F.H.D.
3. One high pool: peat pools about 2,000 feet, Rydal Fell, WL, Black, 1904.

*Platambus maculatus* Linn.

1. Fifteen specimens from 9 stations in 3 lakes: Windermere (6), WL: Ullswater, WL: Bassenthwaite (2), CU; 2 specimens from a high tarn: Blea Tarn, Wythburn, WL.

   *Remarks.* All six stations in Windermere were on exposed shores; those in the other two lakes were reed-beds. Exposed conditions with stony shores were found also in Blea Tarn.

2. Four lakes: Ullswater, CU/WL, dark form, 12.ix.21, E.J.P.: Windermere, WL, 14.vii.32: Bassenthwaite, CU: Buttermere, CU, vii.32, F.B.-B.; 2 high tarns: Easedale Tarn, WL, coll. A. Thornley, F.B.-B.: Watendlath Tarn, CU, with var. *immaculatus*, 11.v.38, F.H.D.
3. One lake: ab. *immaculatus* Donis. abundant in Lake Ullswater, CU/WL, Britten, 1907: var. *immaculatus* Donis., Ullswater, CU/WL, (Britten & Day) Day, 1912.

*Ilybius fuliginosus* Fab.

1. Seven specimens from 7 reed-beds in 5 lakes: Windermere, WL: Coniston (2), WL: Grasmere, WL: Loughrigg 'Tarn,' WL: Bassenthwaite (2), CU; 5 specimens from 3 low tarns, 1 CU, 2 WL; 2 specimens from 1 low pool, WL.

2. One lake: Bassenthwaite, CU, vii.32, F.B.-B. ; 1 low pool: pool beside Ennerdale, CU, vii.32, F.B.-B.

*I. ater* Deg.

1. Two specimens from reed-beds in 2 lakes: Windermere, WL: Coniston, WL.

2. One lake: Buttermere, CU, vii.32, F.B.-B.

*I. guttiger* Gyll.

1. One specimen from a low pool, WL.

3. One unspecified locality: 'two small puddles each about a yard across at the widest part,' Blackburn, 1864.

*I. aenescens* Thomp.

1. Two specimens from 2 low pools, both WL.

3. One high pool: Styhead, CU, Day, 1912.

*Rantus exsoletus* Forst.

1. Four specimens from 4 low tarns, all WL; 2 specimens from a quarry pool, WL.

*R. bistriatus* Berg.

1. One specimen from 1 low tarn, WL; 6 specimens from 4 low pools, all WL; 2 specimens from 2 high pools, 1 WL, 1 CU; 1 specimen from a high tarn, CU.

2. One low pool: boggy pond, Bowscale, CU, 29.viii.36, F.H.D.

3. One high tarn: Sprinkling Tarn, CU, Day, 1912.

*Colymbetes fuscus* Linn.

3. One unspecified locality: Patterdale, WL, (Britten) Day, 1918.

*Dytiscus marginalis* Linn.

1. Several specimens from 3 high pools, 1 WL, 2 CU; 2 specimens from 2 low pools, both WL; 2 specimens from 2 quarry pools, both WL.

2. One high pool: pool above Angle Tarn, CU, coll. A. Hastings, 1932, F.B.-B. ; 1 low pool: boggy pond, Bowscale, CU, 29.viii.36, F.H.D. ; 1 high tarn, Sprinkling Tarn, CU, 9.vi.09, F.H.D.

3. One unspecified locality: Patterdale, WL, (Britten) Day, 1918.

*D. semisulcatus* Müll. (=*punctulatus* Fab.).

1. One specimen from a low pool, WL; 1 specimen from a quarry pool, WL.

*Acilius sulcatus* Linn.

1. One specimen from 1 low tarn, WL; 9 specimens from 4 quarry pools, all WL; 3 specimens from 2 high pools, both WL.
2. One low pool: boggy pond, Bowscale, CU, 29.viii.36, F.H.D.
3. One unspecified locality: Patterdale, WL, (Britten) Day, 1918.

## 5. Notes on Ecology.

None of the species appears to be restricted to a narrow range of habitat requirements, but certain general conclusions about the ecology of the commoner species may be drawn. These conclusions are brought out most clearly in a tabular summary such as is shown in Tables 1 and 2. It may be repeated that in these tables each tarn and pool is treated as a unit, while in lakes each station, usually a reed-bed or a strip of shore, is taken as a unit. The number of lake stations and the number of low tarns, low pools and high pools are all approximately the same, in the neighbourhood of fifty; high tarns and quarry pools are fewer; more exact figures are given below. Running waters have not been worked properly and must be disregarded.

Table 1.

Summary of Records of *Haliplidae*.

| | Running water. | Lakes. | Low tarns. | Quarry pools. | Low pools. | High pools. | High tarns | Unspecified. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| *B. elevatus* | 1 | — | — | — | — | — | — | — | 1 |
| *H. immaculatus* | — | 1 | — | — | — | — | — | — | 1 |
| *H. lineolatus* form *nomax* | — | 11 | 1 | — | — | — | — | 1 | 13 |
| *H. flavicollis* | — | 11 | 2 | — | — | — | — | 1 | 14 |
| *H. fluviatilis* | 1 | 1 | 1 | — | — | — | — | — | 3 |
| *H. wehnckei* | 1 | 12 | 3 | — | — | — | — | — | 16 |
| *H. fulvus* | — | 24 | 18 | 2 | — | — | 2 | — | 46 |
| *H. heydeni* | — | 2 | — | 2 | 1 | — | 1 | — | 6 |
| *H. ruficollis* | — | 7 | 9 | 1 | 2 | — | — | — | 19 |
| *H. lineatocollis* | 1 | 5 | 1 | 2 | 1 | — | 1 | — | 11 |
| *H. confinis* | — | 3 | 5 | — | — | — | — | — | 8 |
| Total | 4 | 77 | 40 | 7 | 4 | 0 | 4 | 2 | 138 |

TABLE 2.

Summary of Records of commoner *Dytiscidae*.

| | Running water. | Lakes. | Low tarns. | Quarry pools. | Low pools. | High pools. | High tarns. | Unspecified. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| *Platambus maculatus* | — | 14 | — | — | — | — | 3 | — | 17 |
| *Deronectes depressus* | 2 | 28 | 5 | 1 | — | — | — | — | 36 |
| *Hydroporus pictus* | — | 6 | 5 | 1 | — | — | — | — | 12 |
| *Ilybius fuliginosus* | — | 8 | 3 | — | 2 | — | — | — | 13 |
| *Deronectes duodecimpustulatus* | 2 | 3 | 2 | 1 | — | — | — | — | 8 |
| *D. assimilis* | 1 | 10 | 6 | 2 | 1 | — | — | 1 | 21 |
| *Hydroporus palustris* | — | 14 | 13 | 5 | 5 | 2 | 1 | — | 40 |
| *Hygrotus inaequalis* | — | 4 | 7 | 1 | — | — | — | — | 12 |
| *Hyphydrus ovatus* | — | 4 | 7 | 1 | — | 1 | — | — | 13 |
| *Agabus sturmii* | — | 1 | 6 | 3 | 2 | 1 | — | 1 | 14 |
| *Rantus exsoletus* | — | — | 4 | 1 | — | — | — | — | 5 |
| *Acilius sulcatus* | — | — | 1 | 4 | 1 | 2 | — | 1 | 9 |
| *Hydroporus incognitus* | — | — | 1 | 3 | — | 1 | — | — | 5 |
| *H. erythrocephalus* | — | 1 | 4 | — | 8 | — | — | — | 13 |
| *H. tristis* | — | — | 1 | 1 | 4 | 2 | — | 1 | 9 |
| *Rantus bistriatus* | — | — | 1 | — | 5 | 2 | 2 | — | 10 |
| *Hydroporus nigrita* | — | — | — | 2 | 2 | 1 | — | 1 | 6 |
| *H. gyllenhalii* | — | 1 | 2 | — | 7 | 2 | — | — | 12 |
| *Agabus bipustulatus* | — | — | 2 | 4 | 6 | 16 | 5 | — | 33 |
| *Hydroporus pubescens* | — | 1 | — | 4 | 7 | 12 | — | — | 24 |
| *Dytiscus marginalis* | — | — | — | 2 | 3 | 4 | 1 | 1 | 11 |
| *Hydroporus obscurus* | — | 1 | 1 | — | 5 | 6 | — | 1 | 14 |
| *Agabus congener* | — | — | — | — | — | 6 | 4 | 1 | 11 |
| *A. arcticus* | — | — | — | — | — | 10 | 1 | — | 11 |
| *Hydroporus morio* | — | — | — | — | — | 14 | 1 | — | 15 |
| TOTAL | 5 | 96 | 71 | 36 | 58 | 82 | 18 | 8 | 374 |

In Table 1 the records for the distribution of Haliplidae are presented. It will be seen at once that members of this family occur sparingly in smaller bodies of water and that the chief habitats are provided by the lakes. All ten species of *Haliplus* are recorded from lakes, and only three, *H. ruficollis, H. lineatocollis* and *H. confinis,* are recorded more often from other localities than from lakes. As already noted, *H. fulvus* and *H. flavicollis* are the only species which have been found at stations where there was not thick cover.

In Table 2 the distribution of the commoner Dytiscidae is presented in tabular form; only those species which have been recorded at least five times are included. Unlike the Haliplidae,

the Dytiscidae are found in all the different types of water-body, and it will be seen that they may be divided roughly into three ecological groups: (i) *Lake group.* Seven species have been found more often at lake stations than in any other type of water-body. *Platambus maculatus* and *Deronectes depressus* have the highest percentage of occurrences in lakes, and it is noteworthy that they are both species which occur on exposed shores. The remaining species show a progressive tendency to occur more frequently in other types of water-body. With the exception of *Platambus maculatus,* all the species in the lake group occur also in low tarns. (ii) *Low tarn—low pool group.* Ten species, none of them occurring very frequently, fall into this small and ill-defined intermediate group. (iii) *High tarn—high pool group.* There are eight species, of which three have not been found in other types of locality, while the rest show a progressive tendency to occur more frequently in other types of water-body.

Further evidence about the habitats occupied by water-beetles may be obtained by considering the habitats themselves.

*Lakes.* Except for *Haliplus fulvus, H. flavicollis, Deronectes depressus, Platambus maculatus* and *Oreodytes septentrionalis,* beetles are only found in old well-developed reed-beds or in creeks where plants such as *Myriophyllum,* which usually only grow in deeper water, are found near the surface. They are not often found in large numbers, and extensive fishing in a reed-bed will not often yield more than two or three beetles.

*Low tarns.* Forty-five have been examined and beetles have been found in nearly all, though they have seldom occurred in large numbers. The commonest plant is *Potamogeton natans* Linn., but it seldom harbours more than a few examples of *Deronectes* spp.; a richer beetle fauna, both in numbers and species, is only found where there are dense beds of submerged plants, such as *Apium, Myriophyllum* and *Callitriche,* or where thick cover is provided by a reed-bed.

Three Dubs Tarn may be described more fully, as it has been worked thoroughly twice a year. It covers an area of about 10,000 sq. m. and has a greatest depth of 3 m. (10 feet). The bottom is peaty, though at some places round the edge there are bare stones; the water has a pH of about 6·5 and contains about one part of calcium per thousand parts of water. There is one patch of *Potamogeton natans* Linn. in the middle, and near the edges there are isolated tufts of *Apium inundatum* Reichb., *Callitriche intermedia* Hoffm. and *Juncus fluitans* Lam. In one place there is a bed of *Juncus* and *Sphagnum.* Outside this bed the beetle population consists only of an occasional *Haliplus fulvus* and *Deronectes 12-pustulatus*; inside it, often in places where water is not apparent till the *Sphagnum* is stepped on, beetles are abundant. Since the collections contribute evidence about

the permanence of the fauna, clearly an important consideration in ecological work, they may be quoted in full:—

Table 3.

| | 24.iii.37 | 16.ii.38 | 2.viii.38 | 8.ii.39 | 26.vii.39 |
|---|---|---|---|---|---|
| *Hydroporus tristis* ..... | 10 | 5 | 19 | 2 | 12 |
| *H. gyllenhalii* ..... | 11 | 18 | 8 | 21 | 6 |
| *Agabus affinis* ..... | 4 | 2 | 3 | 1 | 3 |
| *A. sturmii* ..... | — | — | 2 | 6 | — |
| *A. bipustulatus* ..... | — | — | 1 | 1 | — |
| *Haliplus fulvus* ..... | 1 | — | 1 | — | — |
| *H. ruficollis* ..... | — | 1 | — | — | — |
| *Hydroporus umbrosus* . | 1 | — | 1 | — | — |

*High tarns.* Fifteen have been visited but beetles have only been found in four. *Agabus bipustulatus, A. guttatus, A. arcticus, Haliplus fulvus* and *Platambus maculatus* have been found sheltering among bare stones, while a single *Dytiscus marginalis* was taken in Codale Tarn, where there is a well-developed marginal overhang.

*Low pools.* Only fifteen out of fifty contained beetles. Of the fifteen, six were little more than flooded hollows, two were rock crevices filled with dead leaves and seven were more permanent and had thick cover. Some of the richest catches, both in number of species and in number of individuals, were made in these thickly overgrown pools, often in places which appeared to be dry but which had standing water below the moss, etc., which grew densely over the bottom.

*Quarry pools.* Although recent quarry excavations which have filled up with rain-water contain little life of any sort, those which have been in existence for some decades have a rich fauna, among which beetles are prominent. Of eight examined, three are quite open and the only cover is provided by large stones on the bottom, one has a marginal vegetation of *Juncus* and moss, two have thick vegetation and two are in a wood and contain many dead leaves. The smaller of these two woodland quarry pools has a marginal overhang of *Sphagnum*, and it contains a more abundant and varied beetle fauna.

*High pools.* These localities are probably, geologically speaking, extremely transitory, first expanding by a process of erosion and then becoming overgrown and finally filled up by vegetation, chiefly *Sphagnum*, which either develops in the middle or encroaches from the sides. Pools where erosion is still taking place have bare peaty bottoms and sheer bare sides. Collecting in twelve such pools only yielded three beetles, though Corixidae, on the other hand, were abundant. Beetles were found in twenty pools where vegetation is developing, and though there is no exact correlation there is a general tendency towards an increas-

ing beetle population with increasing development of vegetation ; Corixidae become scarcer and are absent from pools where the entire bottom is covered by vegetation. Well-developed overhanging marginal vegetation appears to provide a good habitat for beetles, and the larger ones, such as *Dytiscus* and *Acilius*, are often found here.

It is difficult to generalise about the distribution of water-beetles, for none appear to be confined within a narrow range of habitat requirements. With few exceptions they are only found where there is thick cover. Haliplidae occur very sparingly in the smaller bodies of water ; Dytiscidae are found in all types from the smallest pools to the largest lakes. The greatest number of individuals, though not the greatest number of species, is found in pools.

A collection of specimens and ecological data, fuller than it is possible to publish, have been lodged in the laboratory of the Freshwater Biological Association at Wray Castle.

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* Rydal is in Westmorland.

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